DO ANIMALS THINK ?

The title of my talk requires some explanation. Among ~~interesting~~ problems of ~~interest~~ inherent ~~to~~ to science that remain ~~largely~~ unresolved, is the nature of "conscious intelligence". What does it consist of ? Is it a uniquely human attribute, or do we in some measure share it with other animals ? ~~Most~~ Animals have brains, but do some of them also have minds ? ~~As you can~~ As you might guess the ~~question~~ problem of animal thought is directly and closely connected with the mind / body problem.

Traditional belief systems and philosophers ~~differ greatly~~ widely in their willingness to admit of the existence of mental life in ~~animals~~ non-human animals. Tribal people, children and animal lovers, can empathize with

animals and project their own thoughts into them. Hindus with their belief in transmigration of souls may have no difficulty in imagining themselves residing in the bodies of other animal. Indeed the idea seems to have been employed effectively as a deterrent against wrong-doing. Although the orthodox Catholic Church came to deny the existence of consciousness in animals, the great Christian Religious St Thomas Aquinas had a very charitable view of animal mind. He entertained the Platonic view that souls could be present in vegetables or even in inanimate objects, and followed Aristotle in allowing a certain scaling in consciousness. According to him there is a smooth gradation of souls between plants and God + Animals are different

from plants because they have "sensitive souls" which can "perceive" object through senses. Men were higher than animals in having an "intellectual soul" which can ~~reflect~~ deliberate and reflect on itself but animals, ~~too especially higher animals~~ too have memory, anticipation and purpose.

"Man's superiority to beasts in animal shrewdness and memory does not result from anything proper to the sensitive part, but from an affinity and closeness to intelligence which, so to speak flows into them. These powers in man are not very different from those in animals, only they are heightened"

St Thomas was a member of the Faculty of Theology and wrote in the 13th century. The attitude of

later scholastic thinkers on the subject of animal consciousness seems to have hardened, somewhat.

Rene Descarte (1595 – 1650) occupies a very special place in philosophy of mind. One of the most imaginative mathematicians and physicists of his times. Descartes was a great enthusiast of what was then called mechanical philosophy. He ~~All was a animal~~ reductionist, ~~for exchange~~ ~~activity could be reduced to laws of physics~~ Animals ~~in his view~~ in his view, were unthinking machines or automata, lacking consciousness of the world around them. ~~and all~~ Their activities could be reduced to laws of physics. When it came to men, however Descarte was an orthodox theologian:

"As theological errors go" he wrote" there is none more powerful in leading feeble minds astray from the straight path of virtue than the supposition that the soul of brutes is of the same nature with our own"

(Methods)

~~in Descartes~~

There is thus a ~~unbridgable~~ dichotomy between animals and machines on one side and men with their conscious thought on the other. The thought of man ~~in Descartes views~~ ~~could~~ is not to be explained by mechanics of matter. It requires the existence of a non-material "mind stuff" whose essential ~~attribute~~ activity is thinking. This ~~view~~ ~~philosophy~~

(*) From p 7

~~is called~~ Cartesian dualism.

In many ways Descartes is a paradoxical philosopher. He had a considerable interest in biology, specially in the working of the brain. ~~He is known to have~~ having dissected an oxes eye ~~and~~ had observed ~~that~~ ~~it makes an image~~ inverted image on the retina. He argued that the image inversion did not matter because the key features of the retinal image were carried to the brain along the optic nerve, not the picture itself, a remarkably modern conception. Elsewhere Descarte ~~argues~~ gives a fascinating account of the role of binocular disparity in ~~depth~~ the perception of depth. Descarte produced a theory of taste, smell, hearing and vision. ~~He~~ attributing these sensations to motions in different types of sensory nerves which are extended like threads from brain to all other members. Movements which are excited in the brain rationaly affect the soul or mind which is conjoined to brain"

~~Some of~~ Descartes critics have wondered how a man of ~~such~~ sharp ~~wit~~ an intellect could have fallen into the error of brain/animal dichotomy more than 300 years after Thomas Aquinas. Some have uncharitably ~~overlooked~~ attributed it to a desire to keep on the right side of the Pope. A contemporary animal lover, the Cambridge philosopher ~~Cambridge Dr~~ Henry More wrote to Descarte.

"There is nothing in your opinions that so much disgusts me as far as I have kindness or gentleness as the intercourse and

and murderous view which you bring forward in the Method, which snatches away life and sensibility from all the animals."

~~Among recent advocates of a Cartesian dualism are the eminent neurophysiologists~~ Sir John Eccles and the philosopher Karl Popper (Popper and Eccles, the Self and its brain, 1977) Sir John Eccles the eminent neurophysiologist and the philosopher Karl Popper in their book "The Self and its Brain advocate a modern but barely concealed version of Cartesian dualism.

Popper

A second set of thinkers who (although for entirely different reasons) have reacted strongly against, the use of internal mental states in the description of animal behaviour are the behaviourists, led by the Harvard psychologist B. F Skinner. The behaviourists objections to mentality in animals arises from a desire to make the study of behaviour strictly objective and operational. The purpose of psychology according to them is to explain publicly observable, measurable and recordable activities of creatures. Explanations involving mental states are mostly misleading and inadmissible.

~~The only~~ legitimate Explanations of animal behaviour ~~must be~~ in terms of environmental circumstances and observable features of the organism. The only unobservables that are allowed are certain innate dispositions and conditioned reflexes.

It is now generally agreed that behaviourism went too far in its quest for objectivity. Skinner himself has softened this attitude and urged a ~~behav~~ version of behaviourism in which the reality of internal phenomenon is ~~allowed~~ accepted and introspective access to ~~their phenomena~~ mental states is allowed a legitimate role in psychology. This turning away from the restrictions of original "behaviourism" has been catalysed by independent movements in a number of ~~related~~ fields principally ethology, neuroscience, molecular biology and artificial intelligence (AI). The point of view towards which these sciences are beginning to converge is not very definite or coherent. There is more that has to be questioned than believed, but the assumption that thought is uniquely human is not so widely held.

The ~~special~~ attributes of human thought are associated with culture civilizations, speech, ~~and~~ writing, arts, science and technology but more generally thought ~~can~~ may be defined as any form of mental activity ~~. It includes a variety different modes of mental experience~~ what goes on in our brains. That includes

perception, memory, feeling reasoning, awareness, intention, foresight, abstract thought reflection and creativity. It is no ones care that animal ~~can~~ possess all faculties of the human mind. But two points must ~~but~~ be made. First an animal may have ~~perception~~ some of these and not others, perception but not memory, feeling but not reason or intuition but not reflection. Secondly, and this is a point of ~~considerable~~ some considerable importance in biology, ~~in~~ During evolution unique features of species do not appear full blown out of nothing. The evolution of every property is graded. This is as true of the beaks of finches as of the faculties of animal ~~mind.~~ mind.

Let us consider "intention". In Aristotles metaphysics, there is a sharp distinction between motion and behaviour; behaviour is said to involve intended ~~movements~~ motion. ~~Let us examine this proposition.~~ If you ~~examine~~ watch a suspension of bacteria under a microscope you will see a ~~swarm~~ million of small one-celled creatures swimming to and ~~fro~~ fro in all directions. Their movements ~~are~~ can be described ~~by~~ as what mathematicians call a random walk. If one touches the ~~bacterial~~ suspension with a thin capillary containing a solution of sugar, within a few minutes the bacteria ~~begin to~~ swarm around ~~into~~ into the mouth of the capillary. ~~Bacteria~~ The bacterium responds to the presence of sugar in ~~their~~ its environment by swimming towards its source. The mechanism of ~~this behaviour~~ bacterial chemotaxis has been analysed is great detail and

Earlier

is now well understood. It is also very illuminating. Each cell at one of its ends has a bunch of ~~minute~~ cilia or minute ~~or rotating~~ tails which can rotate in either direction, clockwise or counter-clockwise. When the cilia rotate ~~in~~ clockwise they cohere into a single bundle, a kind of spinning tail which propels the bacterium forward. When they spin in the opposite direction the bundle of cilia fall apart; each cilium spinning on its own makes the bacterium ~~them~~ tumble without moving forward. ~~The~~ ~~direction~~ ~~rotation~~ of ciliary rotation changes direction alternately clockwise to counter-clockwise ~~from clockwise~~ to a vice-versa ~~counter-clockwise~~. ~~The~~ Bacterial swimming movement thus consists of short stretches of ~~relative~~ straigh runs followed by a tumbles. After each ~~the~~ tumble the cell takes off in ~~on~~ a new ~~str~~ direction totally at random. ~~#~~ This random swimming ~~of the bacterial cell~~ has a mean free path which ~~depends upon~~ ~~is related~~ is determined ~~to~~ by the frequency of tumbling. Now if the bacterium is moving towards a source of attractants that is to say, in the direction of increasing concentration it ~~is less like to~~ changes the direction of its ciliary spin, less ~~and~~ frequently ~~undergo~~ a tumble compared to ~~than~~ when it is moving away ~~from~~ the source of attractant or down ~~the~~ a concentration gradient. ~~This changes~~ ~~the~~ At any given instant of the straigh run ~~the~~ the bacterium is as likely to be moving towards the source of sugar as away from it, but the mean free path ~~of~~ of runs towards the source becomes ~~to~~ longer. This changes ~~make~~ the "random walk" into what is called a

a biased random walk. On the aggregate the bacterium gets closer to the source of attractant. ~~The exact mechanism~~ The ~~one-celled creature~~ bacterium does not have a brain and it make no sense to speak of intention here. ~~Instead of intended~~ In place of "intended movements" biologist prefer to talk of "goal oriented movements". The point is that it ~~no~~ takes very little to ~~convert a~~ perfectly random behaviour to goal-oriented behaviour.

Let us pursue ~~example of~~ chemotaxis a bit further by considering how a fly moves towards an attractant odour. I ~~have~~ chosen this example on purpose because for several years my colleagues and I have been studying the perception of odours by the fruitfly, Drosophila and we have learnt something about ~~this aspect of fly behaviour~~. Drosophila has a pair of antennae on it face which carry chemosensory hairs that detect odour molecules. If there is an attractant odour coming from a source towards the fly, let us us say molecules of amyl acetate from a ripe banana, Drosophila will turn ~~towards the source~~ until it faces the source and walk towards it. ~~It is believed that~~ the fly ~~turns~~ orients itself by comparing the signals that originate from the two antennae. When its face is directly ~~pointing to~~ ~~head with~~ the source, ~~then~~ the ~~inputs~~

flux of stimulus on the

~~from the~~ two antenne is symmetric and there is no disparity in ~~the~~ signals reaching the brain from the two sides. Any departure from correct orientation leads to unbalanced input into the ~~the~~ brain; this is ~~quickly~~ swiftly detected and corrected. ~~by re~~ The fly ~~is guided~~ moved towards the source of odour like a guided missile. The its brain of ~~the~~ ~~Drosophila~~ is ~~so~~ wired in such a way ~~as make~~ that it can make highly accurate measurements of the ~~stimulus~~ odour flux ~~on~~ falling on its ~~two~~ antennae. and use this information to determine its course. Surprisingly the fly behaves ~~quite differently~~ in a quite different manner when faced with ~~the odour of~~ benzaldehyde, the odour of bitter almond. It cannot orient towards ~~this~~ the source. As a consequence it turns as often towards source as away from it. On the other hand it walk becomes slower when it ~~meets~~ confronts higher concentrations of benzaldehyde. You can easily see that this will lead to a "biased random walk" away from the source of odour. ~~When My colleague Veronica Rodrigues found that~~ The ~~projection~~ pattern of projection of benzaldehyde-odour signals into the fly's brain is quite different from the pattern produced by attractants. ~~In particular she found that Veronica discovered that~~ The two antennae ~~send~~ cause symmetric excitations on ~~signals to~~ the two side of the brain, ~~so that~~ and the fly cannot know which side the odour is coming from

The interesting point is that the ~~same~~ little animal is employing two quite different strategies ~~for~~ ~~to~~ ~~computing~~ of ~~a purposeful behavioral response to behaviour~~ in response to sensory inputs through the same perceptual modality – one highly evolved, ~~an~~ using a sophisticated guidance system and other ~~a~~ more primitive one, akin to the biased random walk of bacteria.

Does the fly know what it is doing? The answer obviously will depends upon the sense in which one uses the word "know". We are inclined to ~~think of~~ go along with the ~~idea~~ behaviourist ~~injunctions~~ and not invoke "awareness" or ~~any~~ other mental states ~~in explaining such as "awareness"~~ is explaining the ~~olfactory~~ behaviour of ~~fruit~~ flies but one cannot be so sure. Even the olfactory behaviour of Drosophila is more complex than I have described. When the flies are starved, their responses to attractant ~~food~~ odours are accentuated ~~but the avoidance reaction~~ compared to when they are satiated. The avoidance ~~reaction~~ response is relatively unaffected by feeding. On the other hand when they are ~~armed~~ alarmed the avoidance response becomes more pronounced. In order to accomodate these facts in a ~~our~~ behavioral models, we ~~have to~~ invoke the idea of a central state ~~called~~ (CES) in the fly's brain. ~~This is getting close to mental states. Flies also exhibit olfactory learning or associative conditioning.~~ Other insects such

bees or wasps are capable of much more sophisticated behaviour including learning and social interactions. ~~The~~ The chief reason we do not feel compelled to attribute to them mental states akin to ~~our own~~ our own, it seems to me are two. Insects look very different from mammals and we ~~do~~ ~~not~~ do ~~cannot~~ ~~and~~ introspectively read their ~~minds~~ empathise with them in the same ~~way~~ manner as we do ~~with dogs~~. ~~in the case~~ with of dogs and cats. Secondly, and perhaps this is a better reason, the brains of insects are small. They have only some hundreds of thousands of neurons as against ~~more the~~ a 100 billion or so. ~~in our own brains or in other mammals in the brains of~~ humans and other mammal. ~~Most~~ of the bulk insect neurons are probably used up in constructing the ~~is~~ circuits for ~~rigid and~~ their hard wired stereotyped action patterns. But do ~~the~~ insects feel pain or ~~pleasure~~ ~~or do the have any~~ ~~Do kind they possess~~ their brains register conscious sensation? I do not know. ~~One of the A part of the diffe perhaps they are For It is difficult not easy for us to~~ It is not easy for ~~us~~ to ~~intro~~ intuitively divine the ~~feeling~~ and ~~ideas~~ internal states of creatures so different from our ~~selves~~, ~~that is if they are~~ own selves. I know that under certain conditions the fruit flies ~~are~~ can be very uncomfortable but what does discomfort mean to them? ~~On the other hand~~ It becomes easier to talk about the mental states of animals whose bodies and brains are similar to our own.

In the remaining part of my talk I will confine myself to mammals, specially primates.

The intelligence of different species ~~of vertebrates~~ can be gauged from the size of their brain. ~~Although~~ size by itself is not a proper measure of sophistication. The elephant is not the cleverest of mammals. H. J. Jerison plotted the body weights of vertebrates against their brain-weights. He found that brain weight is proportional to the 2/3 power of body weight. As the surface area of a sphere is proportional to the 2/3 power of its volume you might say that brain-weight varies proportionately with body surface. It is not quite clear why this should be so, but the proportionality enables us to define a quantity called EQ or ~~E~~Encephalization Quotient).

$$E.Q = 0.12 \frac{\text{brain weight}}{\text{body weight}}$$

The factor 0.12 is chosen to make the EQ of an average mammal 1. You may get a feeling for what this means by considering the following facts. The E.Q of archaic vertebrates fishes, frogs and ~~reptiles~~ lizards is 0.07. It has not improved much during

Fig.

evolution. Man has an EQ of 7, a hundred times better than fish or frog; Apes have an EQ of 2 and our Australopithecine ancestors had an EQ of 3.

figure In the course of evolution the EQ of mammals remained fairly stationary at about 0.2 for nearly 200 million years; it then began to increase gradually. The EQ of birds rose smoothly between 160 million years and the present epoch. The EQ of mammal began its rise 80 million years ago & in very recent times there was an abrupt increase in the EQ of humans over apes. The special features of the human brain and presumably of the human mind are to be found in this brief tempo of change. Evolution does not consist of an increase in EQ alone. Enlargement of brain capacity goes with increased functional specialization. The primitive vertebrate brain consists of three parts, forebrain, mid brain and hind brain. Each of the primitive vertebrate brain received sensory inputs from different organs. In mammalian brain the two cerebral hemisphere grow out of the forebrain and the cerebellum from the back of the hind brain. The number of cells in the cerebral and the cerebellar cortex increases greatly and these structures become the

dominant features of the brain. ~~From our point of view~~ The brains of primates, chimpanzee, Orangwhan, Gorilla and man are very similar in their organization. T.H. Huxley pointed out nearly a hundred years ago that "every principal gyrus and sulcus of chimpanzee brain is clearly represented in that of man." However the cortex of man has ~~certain unique features, specially the~~ three special areas devoted to speech, ~~which~~ they usually develop on the left side. ~~also~~ Laheralization ~~of brain functions~~ is ~~unique to man~~ feature unique to the human brain.

Metal states are properties of brain. It is therefore natural to assume that the evolution ~~is an aspect~~ of mental abilities is an aspect of brain evolution. ~~Charles~~ Darwin's ~~book~~ in "Expression of Emotions in Animals" is unambiguous on this ~~scot~~ score. Leaving out Descartes and behaviourists most ~~thinkers~~ thinkers seem to agree that animals ~~possess~~ have an awareness of their immediate surroundings. ~~and Moreover they~~ ~~they have consciousness, and memory.~~ Consciousness of sensations are likely to be similar in animal with similar bodies. and brains ~~In thinking about animals thought~~ The question that ~~is likely to arise~~ interests us most ~~in our minds~~ is ~~whether~~ how much are animals ~~are~~ like us, Does their visual system work like ours? Do they have mental imagery, ~~or~~ hopes and fears. or ~~and~~ Do ~~animals~~ they dream?

In the remaining part of my talk I will discuss some experiments [on] the great apes, chimpanzee, Gorilla and Orangutan, the species that are ~~animals~~ closest to us in evolution.

The first major piece of work on the intelligence of chimpanzees is the Mentality of Apes by Köhler published in 1925. In a colony of chimps maintained by the Prussian Academy of Sciences, Kohler carried out observations ~~on problem solving~~ from 1913 to 1917 and ~~came up~~ describing a number of striking examples of intelligent ~~behaviour~~ problem solving behaviour. When a basket of fruits hanging from the roof was ~~swinging~~ the chimps climbed a neighbouring scaffolding and stretched their arms to catch it. Given stripped branches of trees or poles the animal quickly learnt to vault over fences. They also used poles to make bridges or to escape electrical fencing. One female Chica became ~~a~~ particularly good at pole vaulting. ~~With a pole~~ She was able to clear 5 meters with a 4 feet pole. Sticks were ~~regularly~~ used as tool to dig and to poke through wire nets to collect ants. ~~or other food~~

Köhler describes the case of a charitable chimp who threw pieces of bread across the wire net. Others held the bread against the net ~~to~~ to attract the chicken but perversely pulled away and ate it themselves. A particularly vicious chimp attracted the

the chicken with bread and then tried to hurt them by poking with sticks.

Köhler descriptions tend to be somewhat anthropomorphic, and ~~this~~ did not go down well with behaviourist, but ~~this~~ the Mentality of Apes contains extremely valuable data. ~~and~~ Many of Kohler's observation have been confirmed. ~~by subsequent observers.~~ ~~Others Cognitive develop~~ and demonstrate a high level of cognitive ability in chimpanzees.

Cognitive development in baby Gorillas and Chimpanzees follows a similar sequence as in the human children in early life. ~~as one described in children~~. Apes when 6-7 years old can be taught to distinguish changes in shape from changes in volume. ~~Chimpanzees~~ and can grasp the idea of sameness and difference. The Chimpanzee whose abilities we will discuss later Sarah ~~a female chimp~~ classified 'an apple cut with a knife' and 'paper cut with scissors as same. A bowl of water and an apple were classified as different.

~~Symbolic communication~~:

Teaching of Apes:

~~Training~~ Apes in zoos or human homes are highly imitative and form strong attachments to people. They can be readily trained to adopt human habits, dress and decorum including table manners. Several attempts have been made to teach them to imitate human sounds. ~~but not~~ but without much success. Hayes and Nissen (1971) claim to have taught Vicki, a male chimpanzee, four words, mamma, Papa,

cup and up. and a few other noises which were not natural Chimpanzee sounds.

It has been suggested that the vocal organs of apes are not capable of emitting speech sounds. Whether this is due to limitations of the sound-producing organs or of the relevant brain centres, is not easy to determine but the fact remains that apes show a lack of interest in imitating human sound. Gorillas make threatening gestures by beating their chest. Chimpanzees are ~~somewhat~~ more vocal than other apes but they too use gestures, postures and touch ~~much~~ more often than sound. Attempts have therefore been made to communicate with apes ~~using~~ through symbols other than sounds.

Gestures:

Gardner and Gardner (1975-1978) employed a version of American Sign Language (AMSLAN) to train a female chimpanzee Washoe. Washoes learnt to make a number of hand movements which ~~cor~~ represented objects and perceptual cagategories. The sign vocabulary of Washoe included.

Up
Come - gimme
Hat
Dog
Tickle
More - Tickle

Washoe learnt to use some 30 symbols when she was 2 years old and at 4 years she knew 132 signs. This is quite an achievements. ~~The vocabulary of gestures was obviously acquired more easily than the vocabulary of words.~~ These experiments demonstrate a great deal of perception and memory but the critics maintain that the conversation-like attributes of chimpanzee gesturing have been exaggerated. ~~and~~ that it does not approximate to human linguistic competence. In particular there is no evidence of syntax or grammar either in the expression or apprehension of gestures.

Objects as symbols:

Premack (1970-76) employed plastic discs of various shapes to denote objects and concepts. The Chimpanzee Sarah was trained to place sequences of tablets on a board to elicit desired outcomes ie:

Mary give Sarah apple

upon which the trainer Mary would give Sarah an apple. The simplest experiment is a reversal of the request. ie. the train writes

'Sarah give Mary apple'

These instructions either elicited tantrums

or a reordering of the message.

After Sarah had acquired a larger vocabulary, other responses could be dictated.
'Sarah apple cut' or Sarah apple wash.

An elaborate instruction that Sarah followed was a compound of two instances of the same command 'insert'

'Sarah banana dish apple pail insert'
or
'Sarha apple cracker dish cracker pail insert'

~~The point to~~ notice that exactly which food has to be placed in which dish is to be extracted from the position of the symbol in the sequence. It may be too much to call it syntax ~~the~~ but the order of symbols is a part of these instructions. Sarah also learnt to pick cards of different colours and put them upon each other.

In subsequent versions of Premack's experiments token are replaced with real objects. Sarah learnt to use tokens for same, different, yes, ~~and~~

no and question. She could be given a layout, cork question cork. cork question cork and had to respond with same or different. The expected response would be to replace the question token with same. In the same way tokens about tokens were introduced ie colour, shape and size. For instance round question apple would elicit the response round shape apple.

Premack experiments demonstrated that associations between tokens and object classes or the properties they signified could be established very rapidly. Token could clearly signified other things but perhaps it is incorrect to say that they functioned as words in speech or writing.

Keyboard instructions:

Gardners work with gestures and Premacks with tokens has been criticised on the ground that active participation by the trainer leads to unconscious cueing. A third approach that gets over this difficulty uses computer-controlled consoles. The keyboard consists of small screens showing symbols made of lines, dots and circles on a coloured background. When a pattern is touched, it appears on a display screen going from left to right. Symbols are assigned to items of food and drink which can be given to the animal. Other symbols signify give, pour, share, stop etc. The trained chimpanzee can

The trained chimpanzee can type in messages such as "Stark give bannana stop" or 'Stark pour coke stop'. After training is over the trainer leaves the animal alone with the computer. The female chimpanzee Lana could make a variety of requests. In a subsequent experiment two young chimps Austin and Sherman demostrated that they could communicate with each other. The identity of a hidden item of food was communicated by Austin who had seen it being hidded to Sherman who did not known about it. In another experiment one of the chimpanzees requested and received from the other a tool to obtain food. When a tray of food was given to one the chimpanzee without

food used his keyboard to request and the animal with the tray passed it through an opening in the window.

These experiments by Savage-Rumbaugh show that visual patterns on the keyboard had mental associations with other objects. The chimpanzee who pressed the key did so in the expectation that the other animal will hand him the item. This appears to be a close approximation to intentional communication.

Conclusion

The analogy between symbolic communication of primates and human speech has been ~~questioned~~ attacked on several grounds. First there is the criticism that the experiments are bogus because of hidden promptings from

the experimenter. This criticism might apply to some of the experiments but not to all.

A second criticism, coming from linguists relates to the absence of syntax and grammar. A key feature of human language is the hierarchical combination of elements, phonemes into morphemes and morphemes into phrases according to grammatical rules. The artificial systems employed in experiments with apes largely do away with orderly combinations. The serial arrangement of signs is ~~somewhat~~ limited and the evidence for syntactic order is not very convincing.

Yet another ~~three of skepticisms~~ criticism

is that primate communication lacks 'disengagement from context'. The use of symbols is closely tied to immediate tangible goals. It is not clear that the use of symbols reflects anything analogous to 'inner speech' of human.

~~Going back to the title of my talk~~ If we use the world 'think' to mean processes that cannot be separated from human linguistic abilities, then obviously 'animal thought' is a meaningless phrase.

Speech remains the most ~~clearly~~ obvious ~~evident~~ boundary line between us and other animals. ~~On the other hand~~ But if by ~~conscious~~ thinking we mean brain activities which direct perception, memory and action then there are good reasons to

believe that animals think. They do not think exactly as we do, but brain as an organ of thought came into existence long before our times. ~~Some thinking can be done without words~~

The work on primate communication that I have outlined does not claim to show ~~received~~ that apes can do things which are equivalent to human language. But it does show that apes are capable of doing things which are perhaps similar to an earlier stage in the evolution of language. Apes ~~today~~ display a level of cognitive organization which might be sufficient to make the beginning of ~~human~~ language possible.

~~If~~ If ~~we agree that~~ some thinking can be done without words, to ~~us~~ the and

and that

Thought can be a feeling, "a mental disposition, an

Stephen Wallis

image, intention or anticipation" then the

nature of animal thought remains ~~an interesting~~

~~question~~. ~~a highly interesting~~ an

inviting subject.